Shanmuga Industries Arts & Science College T.V.Malai

APRIL/MAY 2025

DPH22 — ELECTROMAGNETIC THEORY

Time : Three hours Maximum : 75 marks

SECTION A — (10 × 2 = 20 marks)

Answer ALL questions.

1. Write down the Poisson's equation and Laplace equation.

2. Define bound charge density in terms of polarization and hence define the electric displacement vector.

3. Give the physical interpretation of Ampere's circuital law.

4. Show that the magnetic scalar potential satisfies the Laplace equation.

5. Explain the term Gauge invariance.

6. What is the importance of maxwells displacement current?

SECTION C — (3 × 10 = 30 marks)

Answer any THREE questions.

16. Derive the multipole expansions of an electrostatic potential due to a localised distribution of charges.

17. Deduce an expression for

    (a) magnetic scalar potential and

    (b) magnetic vector potential.

18. Deduce Maxwell's equation of electromagnetic field and explain their physical significance.

19. Obtain an expression for the energy radiated from an oscillating electric dipole.

20. Explain the propagation of electromagnetic waves in a conducting medium and hence discuss skin depth.

———————

7. What are retarded potentials?

8. Why half wave antenna is commonly used to radiate electromagnetic energy into space.

9. Give the Fresnel's equation when electric field vector E is perpendicular to plane of incidence.

10. A rectangular waveguide filled with air has dimensions a = 1 cm and b = 0.6 cm. Determine the cutoff frequencies of the TE.

SECTION B — (5 × 5 = 25 marks)

Answer ALL questions.

11. (a) Obtain Gauss law in differential form.

Or

(b) Obtain the solution to Laplace equation in Cartesian coordinate.

12. (a) Using Biot-Savart law, show that the magnetic field is solenoidal.

Or

(b) Using Ampere's circuital law, find the magnetic induction B due to a long straight current carrying conductor.

Shanmuga Industries Arts & Science College T.V.Malai

13. (a) State and prove poynting theorem.

Or

(b) Establish the fact that Lorentz gauge condition uncouples the inhomogeneous wave equations.

14. (a) Discuss radiation emission from a small current element.

Or

(b) Write short notes on antenna arrays.

15. (a) Derive the equation for plane electromagnetic waves in free space.

Or

(b) Derive an expressions for reflection of ear wave at a plane interface.